Chemistry & STEM Measurement II

Discussion Questions 1.4

Precision & Accuracy

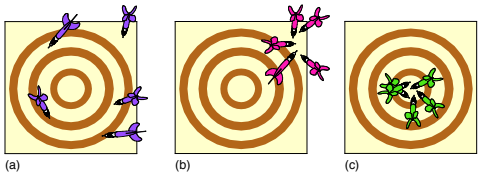
Dr. Ron Rusay

William Tell: his Son & the Arrow

14th Century Swiss Legend & Subject of Rossini's 1829 Opera

https://www.youtube.com/watch?v=hRAFPdDppzs

Precision

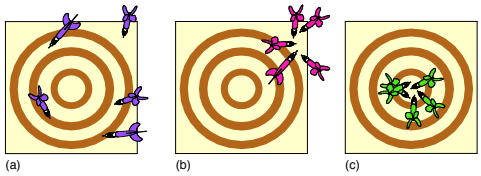


QUESTION:

Rank the images from best to worst precision.

A) a > b > c B) b > c > a C) c > a > b D) c > b > a

Precision



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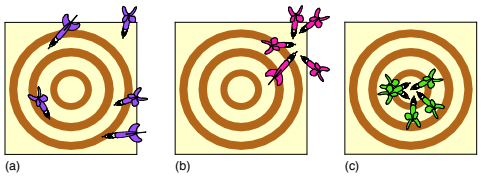

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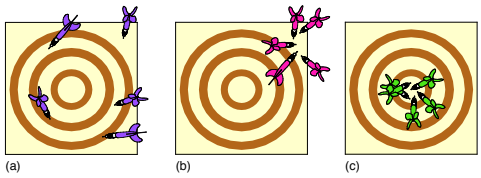

Answer:

Rank the images from best to worst accuracy.

A) a > b > c B) b > c > a C) c > a > b D) c > b > a

QUESTION

Two Chem 108 students are each drinking a can of cranberry juice after class. The printed label indicates that the respective volume of both containers is 375 milliliters. Hanna remarks that the Federal Trade Commision (FTC) requires bottlers to be very precise. Nikko correctly responded:

A. If precision were the only requirement, bottlers could claim any volume as long as it was always very nearly the same volume.
B. Since precision is a requirement, bottlers have to get exactly 375 mL in every can.
C. Bottlers must have a precise average of all of the containers in a case of soft drinks equal to 375 mL.
D. If there were a difference of no more than +/- 1 mL between containers, the bottlers can sell their beverage.

Answer

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D. If there were a difference of no more than +/- 1 mL between containers, the bottlers can sell their beverage.

Precision & Accuracy

(The Following Measured Data is for Volume in mL)

	a)		b)		c)	
	9.52		8.40		7.95	
	8.36		8.35		8.00	
	7.29		8.42		8.05	
	8.34		8.36		7.95	
Average	8.378		8.383		7.988	
Round Off	8.38		8.38		7.99	

	a)	deviation	b)	deviation	c)	deviation
	9.52	-1.14	8.40	-0.02	7.95	0.04
	8.36	0.02	8.35	0.03	8.00	-0.01
	7.29	1.09	8.42	-0.04	8.05	-0.06
	8.34	0.04	8.36	0.02	7.95	0.04
Average	8.378	**0.573**	8.383	**0.028**	7.988	**0.038**
Round Off	8.38	+/- 0.57	8.38	+/- 0.03	7.99	+/- 0.04
		Absolute value (all of the - become +)				

QUESTION

The melting point of pure benzoic acid is 122°C. Data obtained by four students in a laboratory experiment are shown below. Which student's data are the most precise but not the most accurate?

Student A	Student B	Student C	Student D
115°C	119°C	122°C	118°C
112°C	118°C	121°C	120°C
118°C	119°C	122°C	124°C
116°C	120°C	123°C	126°C

A) Student A (115+/-2.5°C) ***B) Student B (119+/-0.8°C)***

C) Student C (122+/-0.8°C) ***D) Student D (122+/-3.7°C)***

Answer

The melting point of pure benzoic acid is 122°C. Data obtained by four students in a laboratory experiment are shown below. Which student's data are the most precise but not the most accurate?

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C) Student C (122+/-0.8°C) ***D) Student D (122+/-3.7°C)***

Precision

(Standard Deviation)

http://en.wikipedia.org/wiki/Standard_deviation

Standard Deviation is the square root of the data set's variance relative to its average (mean). Mathematically:

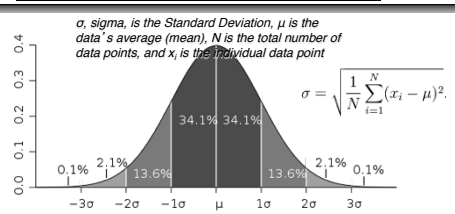
$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}.$$

Where σ, sigma, is the Standard Deviation, μ is the data's average (mean), N is the total number of data points, and x_i is the individual data point.

Precision

(Average Deviation vs. Standard Deviation)

http://en.wikipedia.org/wiki/Standard_deviation



The distribution of data (individual data points) in a set is not considered by the Average Deviation. Standard Deviation, which is the square root of the data set's variance relative to its average (mean), is commonly used to do this.

Precision & Accuracy

Comparing Average & Standard Deviation

(The Following Measured Data is for Volume in mL)

	a)	b)	c)
	9.52	8.40	7.95
	8.36	8.35	8.00
	7.29	8.42	8.05
	8.34	8.36	7.95
Average	8.378	8.383	7.988
Round Off	8.38	8.38	7.99

Standard deviation		Standard deviation		Standard deviation
+/- 0.91		+/- 0.03		+/- 0.05
+/- 0.57	*(Avg. Dev)*	+/- 0.03	*(Avg. Dev)*	+/- 0.04

QUESTION

Rank the relative precision of the three sets of data: a), b) and c). The accepted value is 8.08 mL.

Average		Average		Average
a)		b)		c)
8.38		8.38		7.99

Standard deviation		Standard deviation		Standard deviation
a)		b)		c)
+/- 0.91		+/- 0.03		+/- 0.05

A) Precision: a > c > b

Answer:
B) Precision: b > c > a

C) Precision: a = b > c

D) Precision: a > b > c

QUESTION

Rank the relative accuracy of the three sets of data: a), b) and c). The accepted value is 8.08 mL.

Average		Average		Average
a)		b)		c)
8.38		8.38		7.99

Standard deviation		Standard deviation		Standard deviation
a)		b)		c)
+/- 0.91		+/- 0.03		+/- 0.05

A) Accuracy: a > c > b

B) Accuracy: b > c > a

Answer:
C) Accuracy: c > a = b

D) Accuracy: a = b > c

Experiment #2 – Measuring Density

Accuracy / Error

- *Data Analysis:*
  Accuracy: *#1 = #2 > #3 > #4*

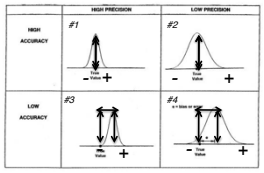
  Error: *#4 > #3 > #1 = #2*

$$Percent\ Error = \frac{Experimental\ value - True\ value}{True\ value} \times 100$$

4 experimental sets of data

True =1.0 g/mL
Exp. = 1.0 g/mL

True =1.0 g/mL
Exp. = 1.1 g/mL



Value = Average

True =1.0 g/mL
Exp. = 1.0 g/mL

True =1.0 g/mL
Exp. = 1.2 g/mL

Experiment #2 – Measuring Density

Precision & Deviation

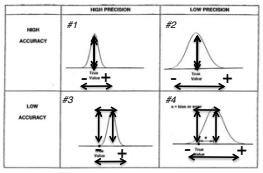
- *Data Analysis:*
  Precision: *#1 = #3 > #2 = #4*

  Deviation: *#2 = #4 > #1 = #3*

4 experimental sets of data

True =1.0 g/mL
Exp. = 1.0 +/- 0.1 g/mL

True =1.0 g/mL
Exp. = 1.1 +/- 0.1 g/mL



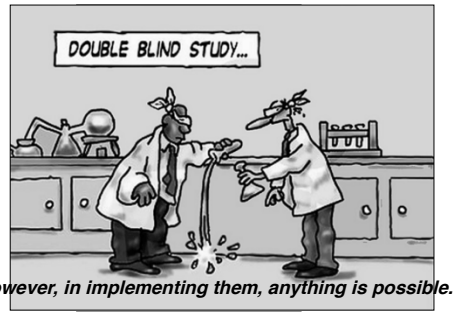
Value = Average

True =1.0 g/mL
Exp. = 1.0 +/- 0.2 g/mL

True =1.0 g/mL
Exp. = 1.2 +/- 0.2 g/mL

Clinical Drug & Vaccine Studies

Follow Strict Procedures & Statistical Rules



However, in implementing them, anything is possible.